Candidate High-Speed Data Acquisition Systems

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Many beam instrumentation applications, e.g. the wall current monitor, require high-speed data acquisition and reduction. This note compares the performance characteristics of currently available high-speed digitizer systems and programmable oscilloscopes suitable for such an application.

A suitable high-speed data acquisition system would have the following characteristics:

- Up to 4 channels;
- High Analog Bandwidth (≥ 1GHz);
- High Sampling Rate (≥ 2 GS/s);
- Moderate precision (≥ 8 bits);
- High backplane bandwidth (≥ PCI);
- The ability to trigger each turn of the Tevatron (≥ 47 kwfms/s);
- Sufficient memory to capture 100 turns (4Mb/channel @ 2Gs/s);
- The ability to synchronize with an external clock;
- A high speed processor with drivers for onboard data reduction; and
- A high-speed network connection.

Such applications can be instrumented using high-speed digitizers or programmable high-speed oscilloscopes.

High-speed digitizers are available from

- Acquiris (www.acquiris.com);
- Analogic (www.analogic.com);
- Gage (www.gage-applied.com);
- Ztec (www.ztec-inc.com).

High-speed oscilloscopes are available from

- Agilent (HP) (www.agilent.com);
- Lecroy (www.lecroy.com);
- Tektronix (www.tektronix.com); and
- Yokagawa (www.yokagawa.com).

Candidate digitizer systems were located by searching for “GHz” and “digitizer” using the Google web search engine. Scope systems were located by examining the web sites of the major oscilloscope manufacturers. Specifications of candidate systems are listed in Table 1.

Systems were included in the table if they offered:

- Sampling Rates of 1GS/s or greater;
- Segmentable Memory (the ability to capture multiple waveforms in data memory prior to readout); and
- 4MB of data memory per channel.

For comparison purposes, some systems were listed if they met only two of the selection criteria.

High-Speed Digitizer Systems

Acquiris

Acquiris manufactures PCI (DP214) and Compact PCI (cPCI) digitizers (DC241) with sampling rates of 2GS/s and analog bandwidths of 1 GHz. Acquiris also offers a 4-channel bundle consisting of 2 dual-channel cPCI boards together with a high-speed fiber-optic interface to a PC.

The analog bandwidth is better than competing digitizer systems, but not as good as the best scopes. Compared to scope systems, however, the Acquiris cards offer much shorter trigger setup time (800 ns). Since an external CPU drives the Acquiris cards, substantially more processing power for data retrieval and reduction can be made available in a digitizer based system than in a scope system. If processing power or data transfer rates are important considerations, separate PCs could be dedicated to each individual channel.

Windows (C++) and LabView drivers are supplied.

Cost is comparable to a scope system of similar performance.

Analogic

Analogic offers several GHz digitizers but the price is higher and the performance is lower than the products available from Acquiris.

Gage

Gage offers a 5GS/s board that uses Tektronix technology, but the memory and the analog bandwidth are very limited. A 2 GS/s board is priced lower than the Acquiris board but the analog bandwidth is limited to 400 MHz.

Ztec

Ztec offers a VXI board with a 1GS/s rate but the analog bandwidth is limited to 300 MHz.

Programmable Oscilloscopes

Agilent

The Infiniium series of oscilloscopes offers a wide range of sampling rates and analog bandwidths, but none of these scopes offer segmented memory. These instruments were included here for comparison purposes only.

Lecroy

The Lecroy Waverunner series of oscilloscopes offers exceptional digitization rates, and analog bandwidths. These scopes also offer the most data memory available (24 Mbytes/Channel). The internal processor, an 833 MHz Pentium III limits the internal processing power.

The scope can be controlled via ActiveX from programs (C++, Visual Basic, Matlab, Excel) running on either the internal processor or an external PC. The software interface may limit the throughput of the internal PCI bus.

Lecroy also offers a lower cost Wavepro Series oscilloscopes based on PowerPC CPU. Remote control from a Windows PC is possible via 10BaseT Ethernet. Because the 10BaseT connection would represent a significant bottleneck, these scopes not considered here.

Tektronix

Tektronix offers a broad range of oscilloscopes that meet the selection criteria. The internal processor and the maximum data memory is more limited than the comparable Lecroy offerings.

A Tektronix 7104 scope has been used successfully to acquire and process data for the Tevatron BLT.

The scopes can be controlled from Windows via ActiveX or TekVISA. Based on experience with the Tevatron BLT, software overhead may limit the maximum data bandwidth to a fraction of the raw PCI transfer rate.

Yokagawa

Prices and some technical specifications for candidate Yokagawa scopes were not immediately available.

Conclusions

Acquiris, Lecroy, and Tektronix offer the most suitable instruments for a high-speed data acquisition system.

The Lecroy scopes offer the most data memory, highest bandwidths, and fastest sampling rates, but at a high price tag.

Tektronix offers a broad range of solutions, but with more limited memory, processing power, and possibly more limited data transfer.

The analog bandwidth and the sampling rate of the Acquiris cards do not match the capabilities of the most expensive oscilloscopes, and the cards are as expensive as scope systems of similar performance. The Acquiris digitizers, however, offer much faster re-triggerability than the scopes. An Acquiris based system would also offer higher data transfer rates and more processing power than oscilloscope based systems because an external PC drives the cards.

The best instrument for any particular application will depend on the tradeoff between the cost of the system and performance demands of the application.

Table 1: Characteristics of High Speed Data Acquisition System and Programmable Oscilloscopes

			GHz		Mbytes/Channel	Mbytes/Channel	GS/s	MWfms/s	k$	k$	k$				MHz		
Acquiris	DP214	8	1	2	0.256	16	2	1.2	13	8.5	4.5	PCI	Yes				
	DC241	8	1	2	0.256	16	2	1.2	21	13	8	cPCI	Yes				
	Cougar 2010-4	8	1	4	0.256	16	2	1.2	44	28	16	cPCI	Yes				Connects to PC via NI MX-3 Optical Fiber
Analogic	DBS907	8	0.5	1	2	8	1	2	11	9	2	VXI	Yes				2 Modules Install in DBS9905 Carrier Board
	DBS908	8	0.5	1	4	16	2	2	29	12	17	VXI	Yes				2 Modules Install in DBS9905 Carrier Board
	DBS909	8	1	1	4	16	4	2				VXI	Yes				Not currently available, 2 Modules Install in DBS9905 Carrier Board
Gage	85G	8	0.5	2	0.01	-	5	-	5	5		PCI	Yes				No Segemented Memory
	85GC	8	0.5	2	0.01	-	5	-	5	5		cPCI	Yes				No Segemented Memory
	82G	8	0.4	2	2	16	2	4.90	10	8	2	PCI	Yes				
	82GC	8	0.4	2	2	16	2	4.90	10	8	2	cPCI	Yes				
Ztec	ZT442VXI	8	0.3	2	0.512	8	1	0.1	11	10	1	VXI	Yes				
Agilent	54830B	8	0.6	2	2	8	2	-	12	12		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54831B	8	0.6	4	2	8	2	-	18	18		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54832B	8	1	4	2	8	2	-	21	21		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54830D	8	0.6	2	2	8	2	-	16.5	16.5		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54831D	8	0.6	4	2	8	2	-	21.5	21.5		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54832D	8	1	4	2	8	2	-	25	25		PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory,Not programmable
	54855A	8	6	4	0.262	32	20	-	63	59	4	PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory
	54854A	8	4	4	0.262	32	20	-	54	50	4	PCI	Yes	Pentium III	833	10/100 BaseT	No Segemented Memory
Lecroy	8300A	8	3	4	2	24	10	0.15	63	43	20	PCI	Yes	Pentium III	833	10/100 BaseT	
	8500A	8	5	4	2	24	10	0.15	75	55	20	PCI	Yes	Pentium III	833	10/100 BaseT	
	8700A	8	6	4	2	24	10	0.15	84	64	20	PCI	Yes	Pentium III	833	10/100 BaseT	
Tektronix	TDS5052	8	0.5	2	0.2	4	2.5	0.225	16	11	5	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS5054	8	0.5	4	0.1	2	2.5	0.225	18	13	5	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS5104	8	1	4	0.1	2	2.5	0.225	18	13	5	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS7054	8	0.5	4	0.1	4	2.5	0.2	30.8	20.5	10.3	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS7104	8	1	4	0.1	4	2.5	0.2	34.8	24.5	10.3	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS7154	8	1.5	4	0.1	8	5	0.4	42.9	28.5	14.4	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS7254	8	2.5	4	0.1	8	5	0.4	50.9	36.5	14.4	PCI	Yes	Celeron	533	10/100 BaseT	
	TDS7404	8	4	4	0.1	8	5	0.4	64.9	50.5	14.4	PCI	Yes	Celeron	533	10/100 BaseT	
Yokagawa	DL7440	8	0.5	4	2	8	2		18.7	13.7	5		Yes			10/100 BaseT	
	DL7480	8	0.5	8	2	8	2		26.7	22.7	4		Yes			10/100 BaseT	